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to refer to the classical work on this subject, Jordan's Traité des Substitutions, and to the periodicals.

Before entering upon the development of more advanced methods of group construction we shall study some of the relations which exist between substitution groups and functions containing a finite number of letters. These relations will not only show how substitution groups may be utilized but they may also serve as a means of arriving at important properties of substitution groups.

Leipzig, Germany, September 20, 1895.

SIMULTANEOUS QUADRATIC EQUATIONS.

By I. H. BRYANT, M. A., Instructor of Mathematics, Waco High School, Waco, Texas.

[Continued from May Number.]

The discussion in this article is restricted to two unknown quantities. Cases 1, 2, 4, and 5 apply to two variables just as they are stated in the previous article. In Case 3, the restriction that each factor must occur twice is unnecessary when only two variables occur. It is sufficient for one factor to occur in each equation. This reduces Case 3 to Case 2. For two variables, Cases 6, 7, and 8 become one and the same, as no restrictions are necessary.

The following Cases are applicable to two variables only. Express the equations thus for Cases 9 and 10:

$$ax^2+by^2+cxy+dx+ey+f=0. \qquad 1.$$

$$a'x^2+b'y^2+c'xy+d'x+e'y+f'=0. \qquad 2.$$

CASE 9. When $a : a' :: c : c' :: d : d'$. If this is true, it is obvious that the terms containing x can be eliminated. This holds true when the terms of any one, or any two, of the three ratios are zero.

CASE 10. When $a : a' :: b : b' :: d^2 : d'^2 :: e^2 : e'^2$, and when $d : d' :: e : e'$.

By alternation, $\dfrac{e}{d}=\dfrac{e'}{d'}$, $\dfrac{b}{a}=\dfrac{b'}{a'}$.

Let $\dfrac{e}{d}=r$. Then $\dfrac{e'}{d'}=r$, $\dfrac{b}{a}=r^2$, $\dfrac{b'}{a'}=r^2$.

$$e=dr,\ e'=d'r,\ b=ar^2,\ b'=a'r^2.$$

Divide equation 1 by ad, and equation 2 by $a'd'$.

$$\frac{x^2+r^2y^2}{d}+\frac{x+ry}{a}+\frac{cxy+f}{ad}=0. \qquad \frac{x^2+r^2y^2}{d'}+\frac{x+ry}{a'}+\frac{c'xy+f^2}{a'd'}=0.$$

Let $x=r(u+v)$, $y=u-v$, and substitute. Eliminate v^2 and solve the resulting equation. The signs of d and e, and of d' and e' must be alike in both, or unlike in both equations. They cannot be alike in one and unlike in the other. Symmetrical equations are a special form of this case.

CASE 11. When the two equations can be expressed as follows:

$$(mx+p)^2-(m'x+p')^2+r(ny+q+n'y+q')=0$$

$$(ny+q)^2-(n'y+q')^2+r'(mx+p+m'x+p')=0.$$

By factoring, one value, and only one, of x and y can be found. The "Harvard Catch" is a special form of this Case.

ARITHMETIC.

Conducted by B. F. FINKEL, Springfield, Mo. All contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

59. Proposed by ISAAC L. BEVERAGE, Monterey, Virginia.

A broker charges me $1\frac{1}{2}$ per cent. brokerage for buying some uncurrent bank bills at 20 per cent. discount. Of these bills, 4 of \$50. each become worthless, but the remainder I dispose of at par, and make by the operation \$364. What was the face amount? [Which answer is correct, \$3000, or \$3048$\frac{24}{37}$?]

I. Solution by J. C. CORBIN, Pine Bluff, Arkansas; H. C. WILKES, Skull Run, West Virginia; and G. B. M. ZERR, A. M., Ph. D., Professor of Mathematics and Applied Science, Texarkana College, Texarkana, Arkansas-Texas.

$80\%+1\frac{1}{2}\%=81\frac{1}{2}\%$; $100\%-81\frac{1}{2}\%=18\frac{1}{2}\%$.

\$364+(4×\$50)=\$564, amount he would have made if he had disposed of all at par.

\$564÷$18\frac{1}{2}\%$=\$3048$\frac{24}{37}$, the correct face amount.

The other result is obtained as follows:

$1\frac{1}{2}\%$ of $80\%=1\frac{1}{5}\%$.